

蝶と蛾 *Tyô to Ga*, 41 (3) : 131 – 138, 1990

Overwintering Aggregation of *Euploea* Butterflies (Lepidoptera, Danaidae) in Taiwan

Minoru ISHII

Entomological Laboratory, College of Agriculture,
University of Osaka Prefecture,
Sakai, Osaka 591 Japan

and

Hirotaka MATSUKA

3-53-14-304 Daita, Setagaya-ku, Tokyo, 155 Japan

Abstract Surveys and observations on the overwintering colonies of *Euploea* butterflies were made in southern Taiwan in the winters of 1978 and 1979 to 1980. The overwintering sites were located in the valleys at the western foot of the Taiwan Central Range at altitudes between 100 and 800 m. Overwintering colonies, which mainly consist of four species of *Euploea* butterflies ; *E. sylvestis*, *E. tulliolus*, *E. mulciber* and *E. leucostictos*, were found forming in natural forests, or in the plantation of teak (*Tectona grandis*) or *Acacia confusa*. Females sampled in late December had no mature eggs in the ovaries, which shows that *Euploea* butterflies pass the winter in the state of reproductive diapause.

Key words Danaidae, *Euploea* butterfly, overwintering ecology, overwintering aggregation, reproductive diapause, Taiwan.

Although the overwintering aggregation of the monarch butterfly, *Danaus plexippus* is one of the most excellent and world-famous natural affairs, there is another marvelous instance where numerous butterflies congregate for overwintering in the mountain forests in southern Taiwan. According to CHEN(1977), in Taiwan there are about 20 congregating areas for wintering butterflies, which he called “butterfly valleys”. Each colony, main members of which are *Euploea* species, consists of hundreds of thousands to more than one million butterflies. CHEN (1977) inferred that the butterflies converge to the “butterfly valleys” in autumn from everywhere in Taiwan.

H. MATSUKA, one of the authors, found a total of 16 “butterfly valleys” in southern Taiwan and made observations of the wintering butterflies in the winters of 1978 and 1979 to 1980. M. ISHII, another author, analysed Matsuka’s data by the analogy of works on the overwintering ecology of the monarch butterfly.

Methods

Surveys and observations of the overwintering *Euploea* colonies were made from 6 to 19 February in 1978 and from 26 December, 1979 to 12 January, 1980. When a colony was found, the location, altitude, exposure and vegetation were recorded. In order to know the species composition and mating activity of the colony, some butterflies were sampled and the collections of commercial collectors were examined. Collections of butterflies were also made at Kenting in the extreme south of Taiwan on 12 and 13 February, 1978 and 1 January, 1979. Abdomens of some female butterflies collected at Liukuei on 29 December, 1979 and at Kenting on 1 January, 1980 were soaked in 70% ethyl alcohol solution immediately after collection and dissected in Japan to determine the developmental stage of ovaries.

Results

Location, size and vegetation of overwintering colonies

The 16 overwintering colonies of *Euploea* butterflies found in the present surveys were located at the western foot of the Taiwan Central Range (Chung Yang Shan Mo) between Chiayi and Fengkang (Fig.1). Their altitudes were ranged from 100 to 800 m with three quarters of the colonies found between 300 and 600 m elevation, and the slopes where butterfly colonies were formed were exposed to fairly various directions, which showed no marked tendency ($P > 0.05$, $\chi^2 = 13.0$, $df = 7$) (Table 1, Fig. 2)

It should be noted that all the overwintering colonies were found forming in the valleys covered with trees of 10–15 m in height. Out of the 16 colonies, eleven were seen in natural forests and the rests were found in the plantations of teak (*Tectona grandis*) or *Acacia confusa* (Table 1).

Though the colony size was not measured in the present surveys, numbers of butterflies in the 16 colonies were roughly estimated to vary from a few thousands to more than 50 thousands.

Butterfly species in overwintering colonies

Overwintering colonies mainly consist of four species of *Euploea* butterflies; *E. sylvester*, *E. tulliolus*, *E. mulciber* and *E. leucostictos* (Table 2). Other species in the colonies include *Tirumala septentrionis*, *T. limniace* and *Ideopsis similis*. *Parantica melaneus*, *P. aglea* and *Salatura genutia* were also found in overwintering grounds but few in number.

Dominant species differed in different colonies and perhaps in different years. The commercial collection made in Colony 1 at Santimen, in Pingtung Prefecture in early February, 1978 was predominated by *E. leucostictos* with the second dominant *E. tulliolus*, while both *E. tulliolus* and *E. sylvester* dominated the one made in Colony 3 at Nansihhu. It is interesting that *E. mulciber*, a small minority in the other colonies, predominated Colony 4 at Liukuei on the basis of commercial collection made in late December, 1979.

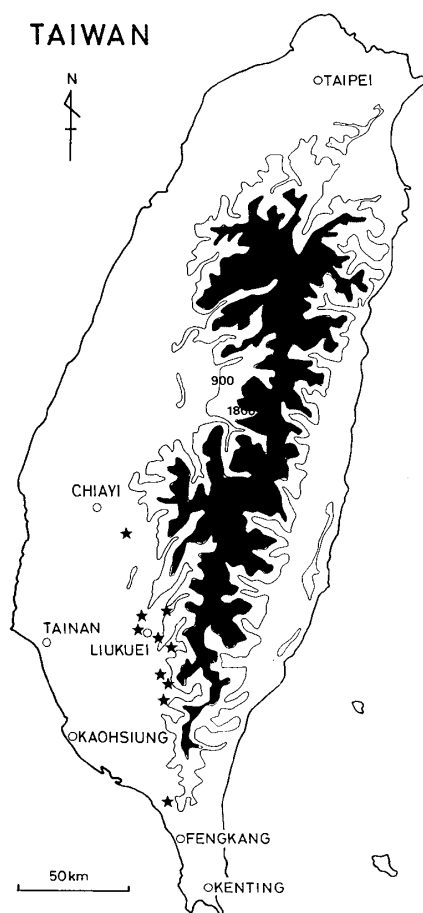


Fig. 1. Location of overwintering sites of *Euploea* butterflies (closed stars) in relation to the topography of Taiwan. Shaded area shows the region higher than 1,800 m and fine lines indicate the 900 m contours.

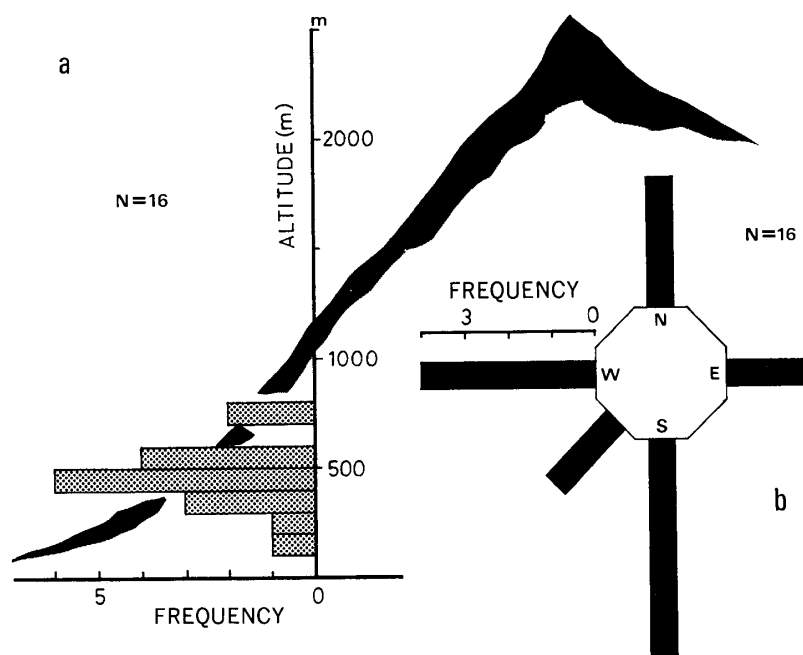


Fig. 2. Distributions of altitude (a) and facing (b) of overwintering sites of *Euploea* butterflies in Taiwan.

Table 1. Physical characteristics of 16 *Euploea* overwintering colonies in Taiwan found from 1978 to 1980. N. F. : natural forest.

No.	Location	Date found	Altitude (m)	Facing	Vegetation
1	Santimen	Feb. 6 1978	430	W	N. F.
2	Maolin	Feb. 8 1978	460	S	N. F.
3	Nansihhu	Feb. 15 1978	160	W	<i>Acacia</i>
4	Liukuei	Feb. 18 1978	420	E	Teak
5	Liukuei	Feb. 18 1978	360	S	N. F.
6	Liukuei	Feb. 18 1978	400	N	Teak
7	Liukuei	Feb. 19 1978	600	S	N. F.
8	Liukuei	Feb. 19 1978	570	W	Teak
9	Liukuei	Feb. 19 1978	510	N	N. F.
10	Liukuei	Feb. 20 1978	340	S	N. F.
11	Liukuei	Feb. 20 1978	420	SW	N. F.
12	Maolin	Dec. 26 1979	700	S	<i>Acacia</i>
13	Liukuei	Dec. 28 1979	500	E	N. F.
14	Liukuei	Dec. 30 1979	800	W	N. F.
15	Santimen	Jan. 4 1980	300	SW	N. F.
16	Kuantsuling	Jan. 10 1980	250	N	N. F.

Table 2. Numbers of *Euploea* butterflies collected at three overwintering colonies and Kenting in early February, 1978. Abdomens of some or all the females were examined by the fingers for spermatophores. Sample number and number of females with spermatophore(s) (i. e., females copulated) are shown in parentheses.

Colony	No. collected (copulated/sampled females)			
	<i>sylvestre</i>	<i>mulciber</i>	<i>leucostictos</i>	<i>tulliolus</i>
No. 1	2♂12♀ (5/12)	31♂19♀ (11/19)	454♂907♀ (18/87)	58♂107♀ (25/70)
No. 2	10♀ (4/10)	6♀ (4/6)	30♀ (11/30)	63♀ (44/63)
No. 3	9♂44♀ (36/44)	1♂2♀ (1/2)	4♂26♀ (4/26)	31♂35♀ (11/35)
Kenting	1♂6♀ (2/6)	2♀ (1/2)	—	10♂5♀ (3/5)

Table 3. Stages of ovaries and copulation ratios in females of 6 danaid species collected at Liukuei and Kenting in late December, 1979.

species	No. examined	stage of ovary ¹⁾				No. ²⁾ (%) copulated
		0	I	II	III	
collected at Liukuei						
<i>Euploea sylvester</i>	10	10	0	0	0	0 (0%)
<i>E. tulliolus</i>	11	11	0	0	0	0 (0%)
<i>E. mulciber</i>	12	12	0	0	0	0 (0%)
<i>E. leucostictos</i>	10	10	0	0	0	0 (0%)
<i>Salatura genutia</i>	20	16	0	1	3	10 (50%)
collected at Kenting						
<i>E. tulliolus</i>	12	12	0	0	0	0 (0%)
<i>Parantica melaneus</i>	2	0	0	0	2	2 (100%)

1) 0 : without visible oocytes ; I : with small oocytes ; II : with large oocytes ; III : with mature eggs.

2) No. of individuals with spermatophore(s).

Behavior of overwintering butterflies

In overwintering sites at Liukuei (Fig. 5), the temperature rose above 17°C in the daytime of clear days in mid winter, while it lowered near 10°C at night.

In the morning, some butterflies were observed to bask on sunny leaves in roosting trees, while others were found taking water at the moist soil in sunny areas along streams (Fig. 6). Dew drops on leaves were also seen taken by butterflies.

At the high noon of sunny days, butterflies were active enough to fly out in response to the noises, and some were observed to fly about the overwintering ground voluntarily (Fig. 4). From late January on, a few species of plant were in flower, and butterflies were often found nectering on mangos. In this period number of mating pairs seen in overwintering sites gradually increased with the progress of the season.

At night, early morning, late afternoon, and on overcast days, butterflies clung tightly to the leaves of trees with oppressing their wings (Fig. 3). It did not seem that butterflies form clusters in the tops of the taller trees during these times.

Reproductive activity

As described above, mating pairs were seen after late January in overwintering grounds. Since mating results in the secretion of a distinctive spermatophore inside the bursa copulatrix, mating activity in the colony would be clarified by the examination of female abdomen for the spermatophore(s) by dissection or even by touch.

All the dissected females of 4 *Euploea* species collected at Liukuei on 29 December, 1979 were proved to have neither mature eggs nor spermatophores (Table 3), which shows that they were in the state of reproductive diapause. Contrastively, *S. genutia* seems to maintain the reproductive activity even in winter : 3 and 1 out of 20 females collected at Liukuei on the same day had mature eggs and large immature eggs, respectively, and half of the females had been mated. Females of *E. tulliolus* from Kenting also showed no symptom of reproductive activity, while 2 dissected females of *P. melaneus* had both mature eggs and spermatophores (Table 3).

In early February, on the other hand, considerable number of females collected in overwintering colonies and at Kenting were proved to have spermatophore(s) by the examination of abdomens by the fingers (Table 2). The results suggest that the state of reproductive diapause in *Euploea* butterflies is terminated by early February.

Discussion

Some of commercial collectors in southern Taiwan may have been aware of the overwintering aggregations of *Euploea* butterflies. According to CHEN (1977), he had grown to believe this phenomenon by the telephone call from a junior school boy on a day of mid December in a year saying that numerous butterflies were flying into a valley at Wantan, where he could locate an overwintering colony. CHEN (1977) has inferred from his mark-and-recapture experiments that butterflies migrate to overwintering sites from breeding grounds in southern and central Taiwan, though no data is shown in his article.

There are several instances of migration of *Euploea* butterflies in Monsoon Asia. For example, considerable number of *E. core* was seen migrating nearly westwards in Suri Lanka in mid December, 1952 (WILLIAMS, 1958), and an enormous migration of *E. modesta* accompanied by fewer individuals of *E. diocletianus* and *E. tuliollus* was observed in Negeri Sembilan, Malaysia from late July to early August, 1959 (CORBET and PENDLEBURY, 1978). Thus it is not impossible that *Euploea* butterflies in Taiwan make migration from one place to another.

Some of *Euploea* butterflies which occur in secondary forests are often seen aggregating on flowers, leaves, tree trunks, the moist ground, animal feces, etc. in breeding season (e. g., MORISHITA, 1977 ; ISHII, 1987). It may safely be said that both migratory and aggregating natures are common for *Euploea* butterflies. Nevertheless it depends upon further studies how and from where the *Euploea* butterflies immigrate into the overwintering grounds in Taiwan.

There are several points of similarity between the overwintering ecology of *Euploea* butterflies in Taiwan and that of the monarch butterfly, *Danaus plexippus*, in Mexico. First, the overwintering colonies are formed in the valleys at the foot of high mountains, though the location of colonies are much higher in the monarch (around 3,000 m above sea level : CALVERT and BROWER, 1986). Second, the overwintering butterflies are in a state of reproductive diapause at least during early and mid winter (see BROWER, 1977). Third, the butterflies in overwintering colonies are seen taking water in stream sides and basking on sunny days (see e. g., BROWER, 1977 ; CALVERT and BROWER, 1986).

However, there is an important difference in the overwintering aspects between the monarch and *Euploea* butterflies : the overwintering grounds in Taiwan are utilized by several danaid butterflies, while those in Mexico are occupied by a single species, the monarch butterfly. It may be due to the fact that there is no species that has the similar overwintering nature to the monarch butterfly in North America.

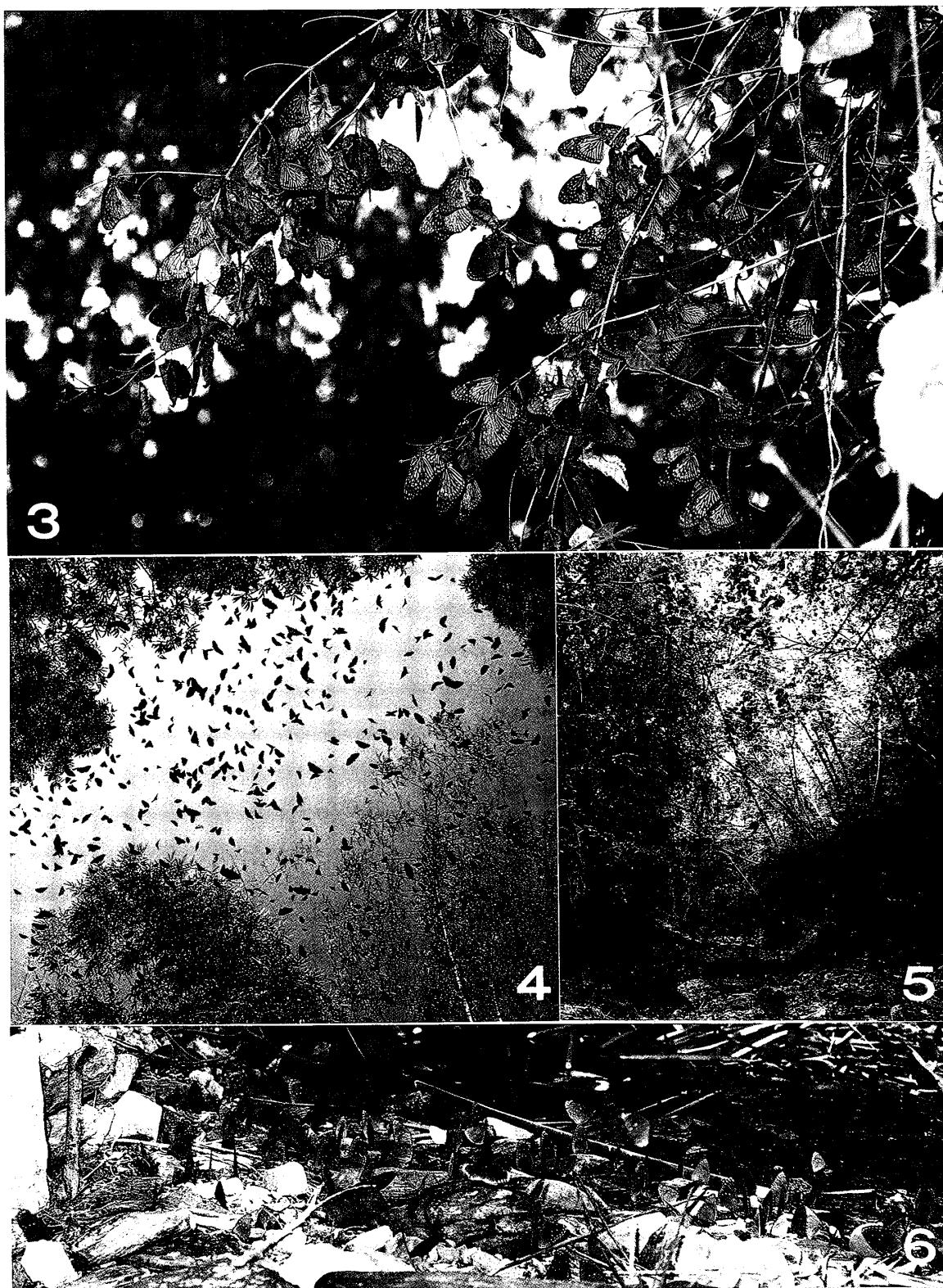
There still remain questions related to the initiation, growth and breakup of the overwintering colonies, adaptive meaning of the aggregation for overwintering, etc. The fact that Taiwan is essentially on the northern limit of *Euploea* butterflies in East Asia might have been responsible for this phenomenon. Further observations and experiments on those aspects are expected.

Acknowledgements

The authors express their sincere thanks to Dr. Y. I. CHU of National Taiwan University and Mr. K. MORISHITA of Lepidopterological Society of Japan for critical reading of the manuscript. Thanks are also due to Mr. W. L. CHEN, a commercial collector of Liukuei, Taiwan for his kind assistance in the present surveys.

References

- BROWER, L. P., 1977. Monarch migration. *Nat. Hist.*, 86 (6) : 40 - 53.



Figs. 3 – 6. 3. Overwintering *Euploea* butterflies clinging to the leaves and twigs of trees. 4. *Euploea* butterflies flying about the overwintering ground in response to the noise. 5. An *Euploea* overwintering site on a small mountain valley at Liukuei, Taiwan. 6. Overwintering *Euploea* butterflies taking water at moist places along a stream.

- CALVERT, W. H. and L. P. BROWER, 1986. The location of monarch butterfly (*Danaus plexippus* L.) overwintering colonies in Mexico in relation to topography and climate. *J. Lepid. Soc.*, **40** : 164-187.
- CHEN, W. 1977. Mysterious butterfly valleys. *The Nature and Insects*, **12** (4) : 7-10. (In Japanese.)
- CORBET, A. S. and H. M. PENDLEBURY, 1978. *The butterflies of the Malay peninsula*, 3rd ed. revised by J. N. ELIOT. 578 pp. Malayan Nature Society, Kuala Lumpur, Malaysia.
- ISHII, M., 1989. Studies on the life histories of tropical butterflies. *Researches on behavioural strategy of small animals in the humid tropics 1987*, ed. by T. HIDAHA. Dept. Zool., Kyoto Univ., pp. 1-13.
- MORISHITA, K., 1977. The genus *Euploea* in the orient (Lepidoptera : Danaidae). *Acta Rhopalocerotologica*, (2) : 1-60. (In Japanese.)
- WILLIAMS, C. B., 1958. *Insect migration*. 237 pp. Collins, London.

摘 要

台湾におけるルリマダラ類の越冬集団 (石井 実・松香宏隆)

著者の一人、松香は1978年の2月と1979年12月から1980年1月までの2回、台湾南部においてルリマダラ類の集団越冬地を調査した。また、松香は越冬中のルリマダラ類の行動を観察し、一部の雌の腹部をアルコールに浸して持ち帰った。腹部の解剖およびデータの解析等は石井が行った。

この調査で、嘉義から楓港の間で16ヶ所のルリマダラ類の越冬地を発見した。これらはすべて、2,000~3,000 m級の山の連なる台湾中央山脈の西麓に位置し、越冬集団は標高100~800 mの渓谷を覆うチークや相思樹の樹林、あるいは種々の雑木から成る自然林内に形成されていた。越冬地の斜面の向きはさまざまであった。各越冬集団の大きさは特に調べなかったが、およそ数千から5万個体以上と見積られた。

越冬集団は、個体数の多いルリマダラ(*Euploea*)属のルリマダラ(*sylvester*)、ホリシャルリマダラ(*tulliolus*)、ツمامラサキマダラ(*mulciber*)、マルパネルリマダラ(*leucostictos*)の他、コモンマダラ(*Tirumala septentrionis*)、ウスコモンマダラ(*T. limniace*)、リュウキュウアサギマダラ(*Ideopsis similis*)を中心に構成されていたが、タイワンアサギマダラ(*Parantica melaneus*)、ヒメアサギマダラ(*P. aglea*)、スジグロカバマダラ(*Salatura genutia*)も少ないながら見られた。また、集団により優占種は異なっていた。

越冬地のルリマダラ類は、朝林内に日が射すと活動を始め、午前中は日光浴や吸水などの行動が観察された。吸水の際は、葉の上の露を吸うものもあるが、溪流の岸辺に下りるものもあった。1月下旬以降はマンゴーなどの花で吸蜜する個体も見られ、交尾ペアも確認された。白昼、気温の高い時は、蝶たちは物音に驚いて飛び立つことが多かったが、天気の良い日や夜は、林内の樹木に樹冠部を避けて静止していた。

1979年12月下旬に六亀の越冬地で収集したルリマダラ4種の雌の卵巣は未成熟で、精包も認められなかった。また、台湾最南端の墾丁公園で採取したホリシャルリマダラ雌の腹部にも成熟卵や精包は見られなかった。冬期のルリマダラ類は生殖休眠の状態にあると言える。

一方、同時期に六亀の越冬地で採取したスジグロカバマダラ20個体のうち4個体には成熟卵や大きな未成熟卵が、10個体には精包が認められた。また、墾丁公園で捕らえたタイワンアサギマダラ2個体は、ともに成熟卵も精包ももっていた。これらのマダラチョウは冬でも繁殖を続けているものと推定される。

(Received 15 September 1989)

Published by the Lepidopterological Society of Japan, c/o Ogata Hospital, 3-2-17 Imabashi, Chuo-ku, Osaka, 541 Japan